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Suppressants for Lowering Propellant Binder Burning Rate

Solid propellants which have a slow rate of burning are required for extended space flights. Ordinarily, solid propellants burn quite rapidly, but some additives can be incorporated in propellant compositions to moderate the rate of burning. Although a wide variety of additives have been tested, very few have been found to alter the burning rate significantly. The most effective additives known thusfar influence the rate of reaction of the oxidizer; small changes in rate are magnified because the oxidizer is the major component of the propellant system. An attractive possibility for further reduction of propellant burning rate lies in modification of the usual binder systems, and in a study of propellants prepared with a polyurethane binder system and a polyether backbone, it was shown that burning rates could be suppressed by a phosphorus-containing chain extender and a combination of phosphorus and boron compounds as plasticizer. However, phosphorus plasticizers are not very satisfactory because they are volatile and migrate to nonpropellant portions of the rocket engine.

The chain extender in most polyurethane propellant binders is usually a dihydroxy compound which is copolymerized along with the principal hydroxy compound in the binder. By substituting a phosphorus-containing dihydroxy compound for the usual chain extender, a phosphorus moiety is chemically bound to the polymer chain of the polyurethane binder and thus is not free to migrate. A compound of this type which has been found suitable is diethyl-N,N-bis (2-hydroxyethyl)-aminoethylphosphonate.

Lower burning rates were also observed when a boron compound, trimethoxyboroxene, was used in place of a phosphorus plasticizer such as isodecyldiphenyl phosphate. Additionally, by combining the phosphorus plasticizer with trimethoxyboroxene at a total level not exceeding that used for either compound separately, an even lower burning rate was observed; this synergistic effect was unexpected. However, additional advantages can be realized because each component is used at a lower concentration and thus their vapor pressures and migration tendencies are minimized.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
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NASA has decided not to apply for a patent.

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